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Rassieur et al.

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[54] **HYDRAULIC KELLY BAR CHUCK**

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[73] Assignee: **Central Mine Equipment Company**, St. Louis, Mo.

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[51] **Int. Cl.**[4] **E21B 3/04**

[52] **U.S. Cl.** **173/163**; 173/152; 279/4

[58] **Field of Search** 173/163–166, 173/152; 175/195; 279/4

[56] **References Cited**

U.S. PATENT DOCUMENTS

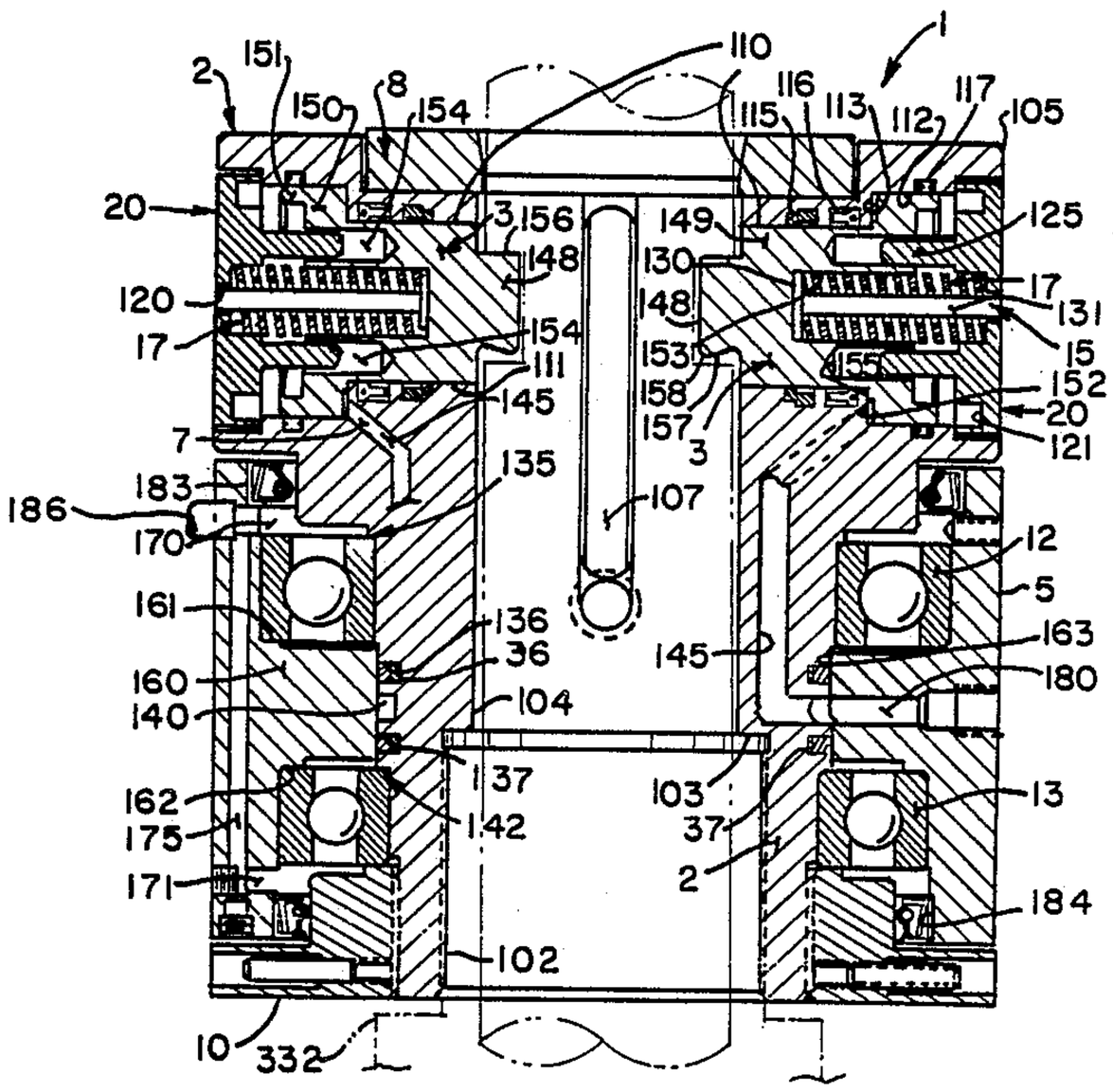
1,809,444	6/1931	Greve	173/164
3,561,545	2/1971	Rassieur	173/166
4,393,945	7/1983	Rassieur	173/163

Primary Examiner—Frank T. Yost
Assistant Examiner—James L. Wolfe
Attorney, Agent, or Firm—Polster, Polster & Lucchesi

[57] **ABSTRACT**

In a rotary drill having a driven rotary table with an axially directed passage through its center of rotation defined by a hollow spindle, a kelly bar extending through the passage, and a chuck mounted on the spindle, plungers are mounted in cylinders in the chuck for radial movement into and out of engagement with shoulders on the kelly bar. A housing surrounds a portion of the chuck. The housing is held against rotation and has a fluid passage through it communicating with an annular manifold channel. Fluid passages in the chuck, associated with each cylinder, communicate at one end with the manifold channel and at another end with the cylinder radially inboard of a piston part of the plunger. Oil under pressure to move the plungers out is caused to leak into bearings positioned axially above and below the manifold, to lubricate, flush and cool them. The plunger has a nose with a depending lip that engages an upper or lower shoulder of the kelly bar when the chuck is forced up or down to drive the kelly bar upwardly or downwardly.

14 Claims, 3 Drawing Sheets



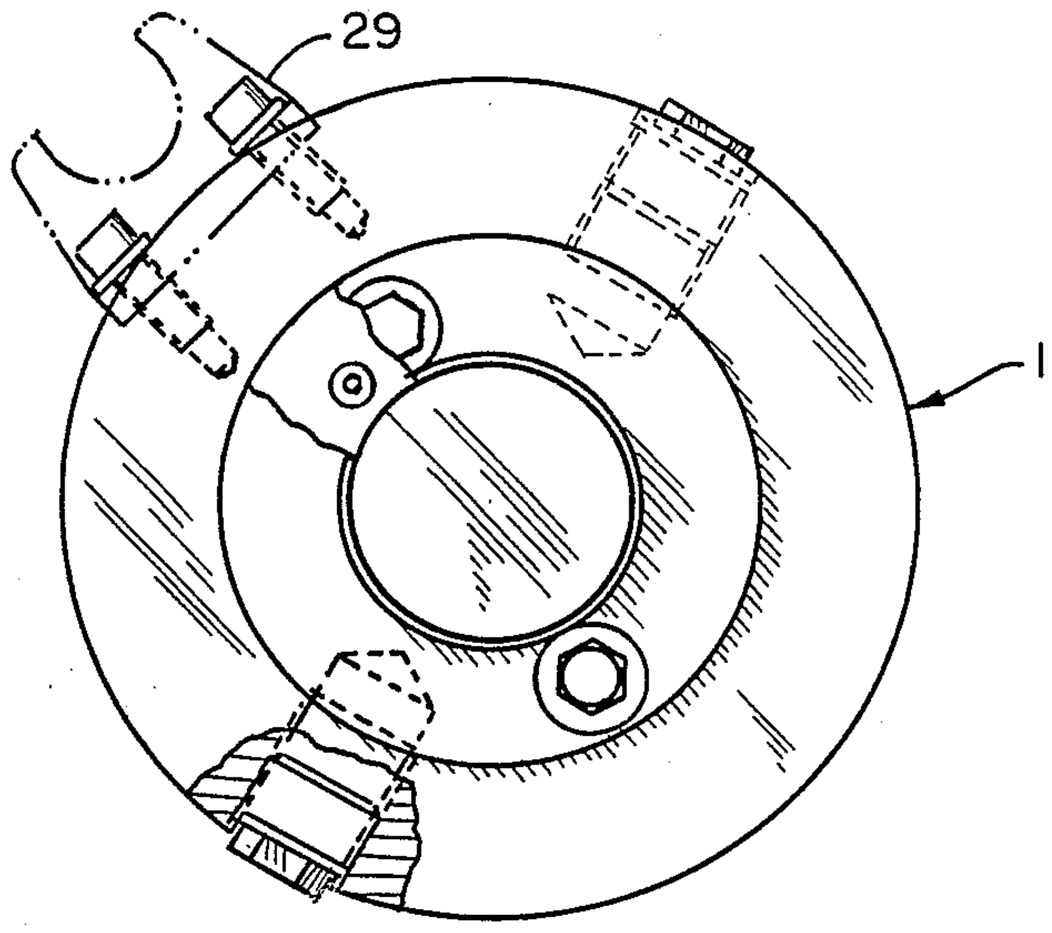

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FIG. 1.

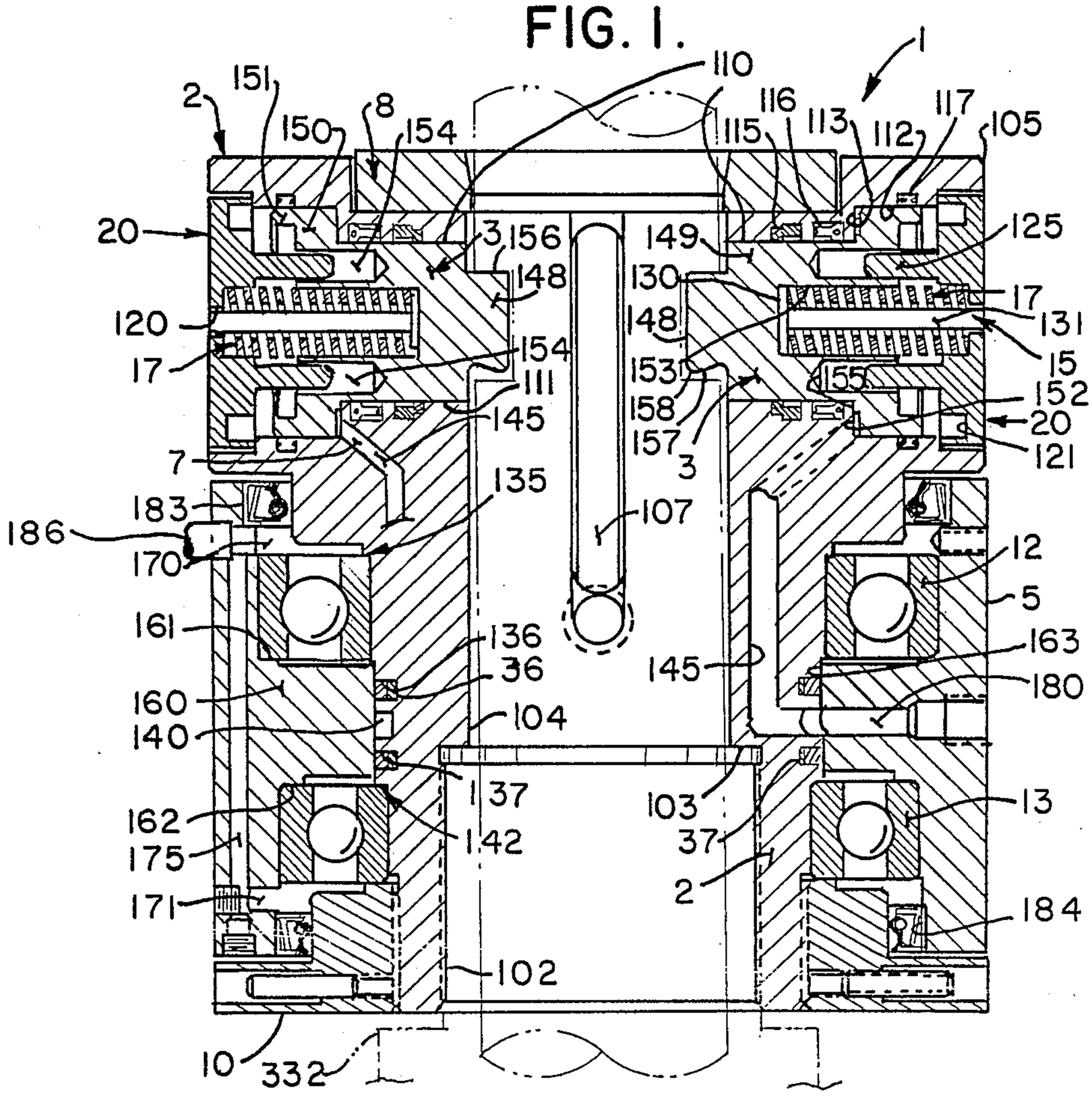
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FIG. 2.

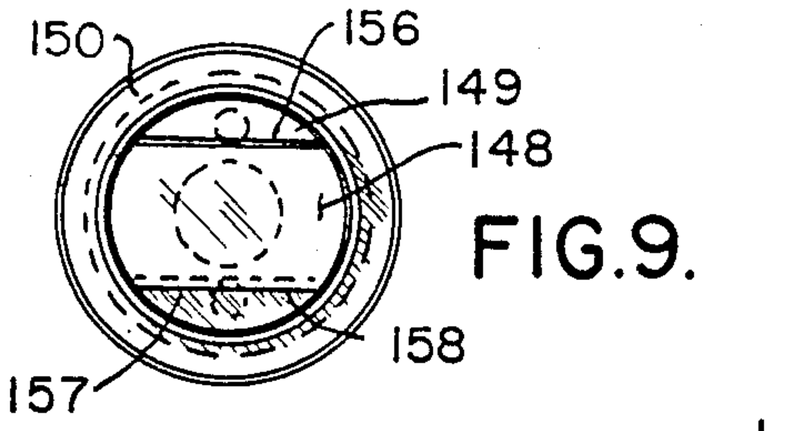


FIG.9.

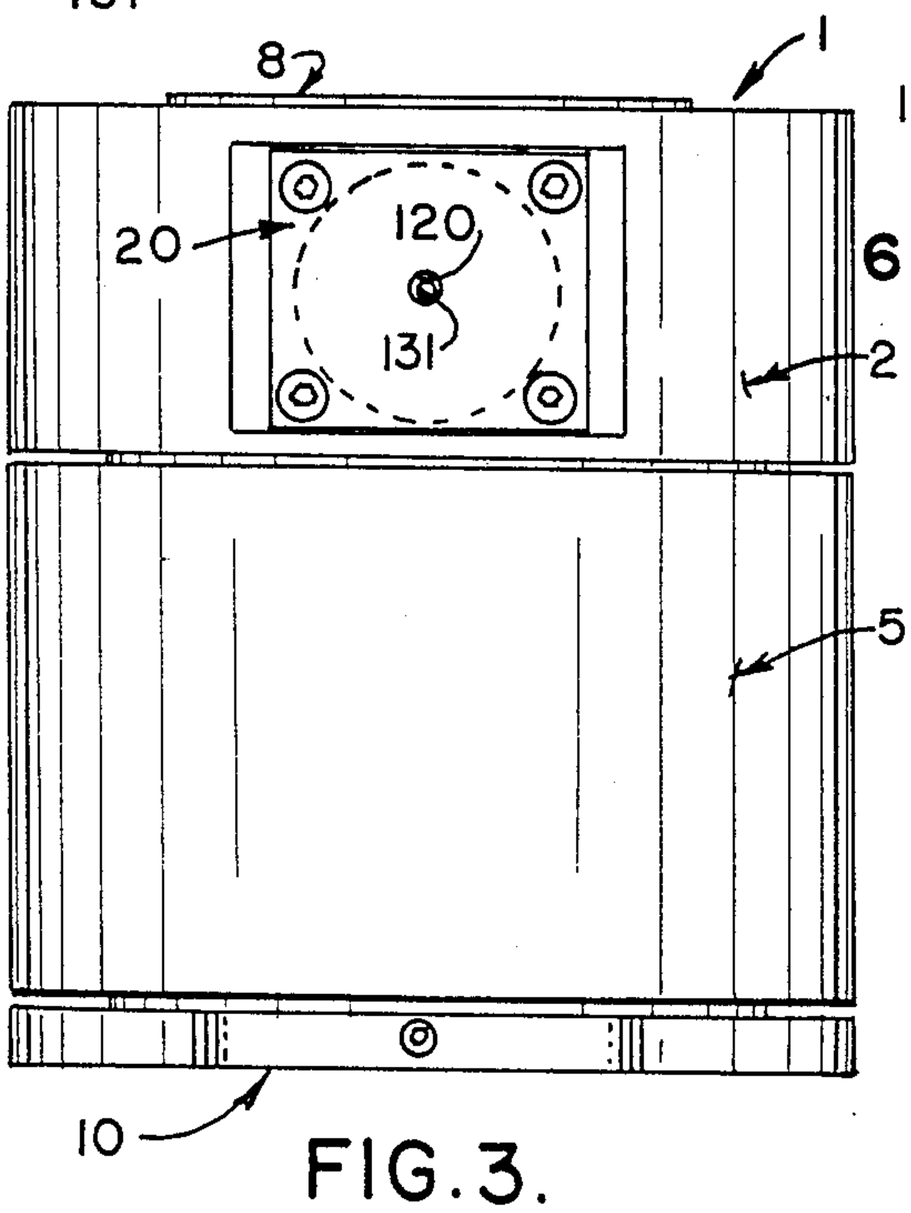


FIG.3.

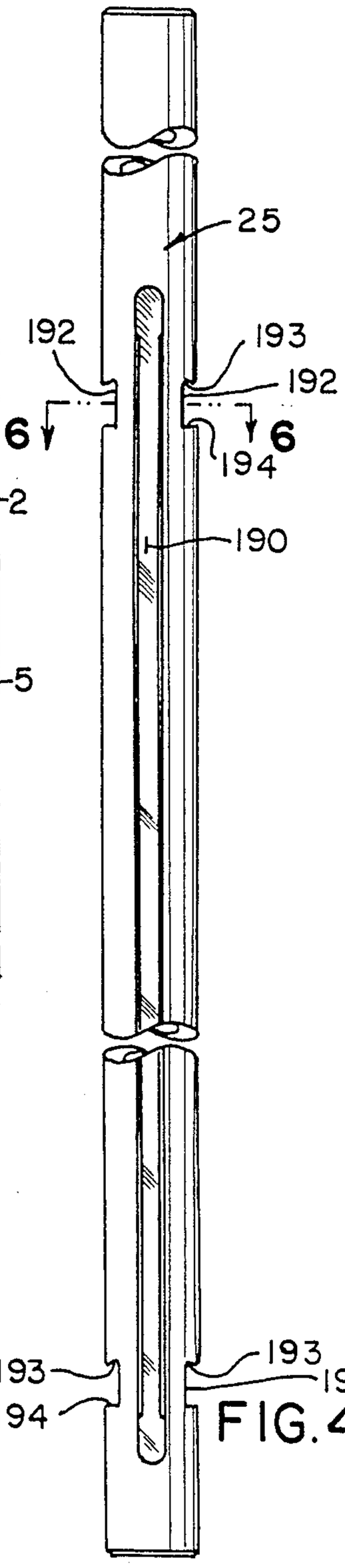


FIG.4.

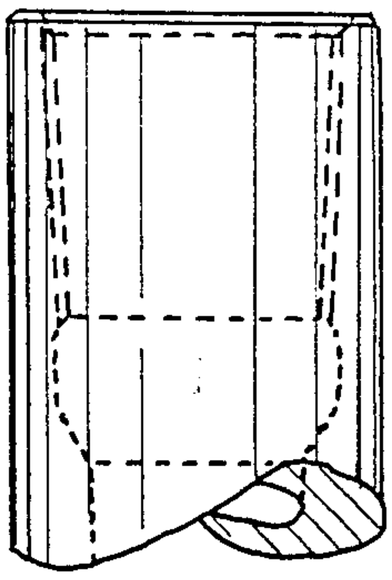


FIG. 5.

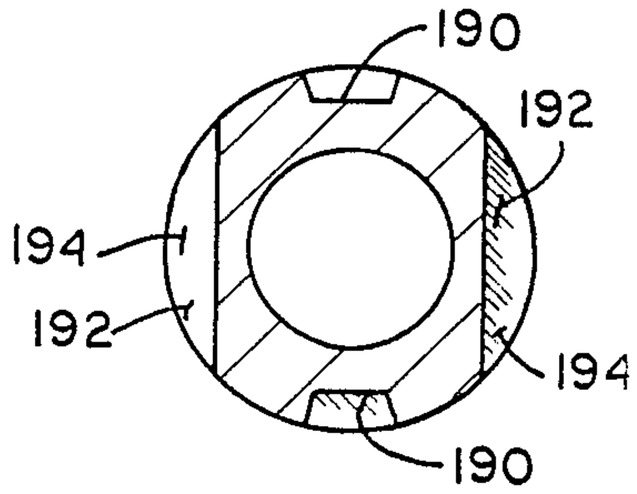
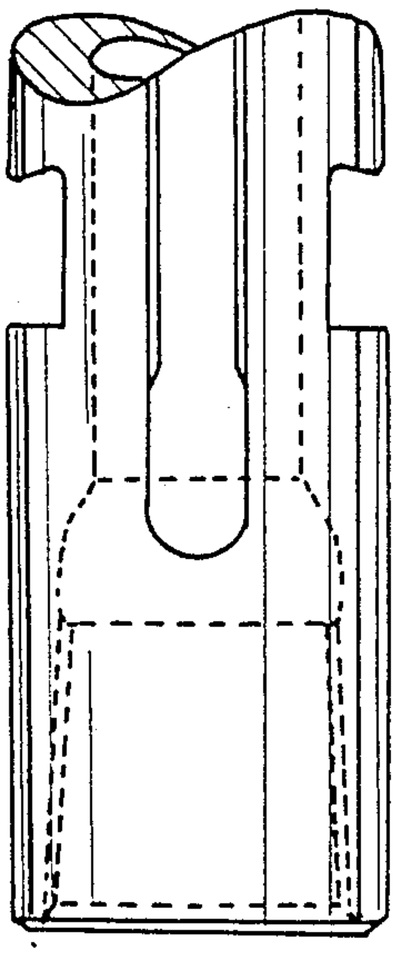


FIG.6.



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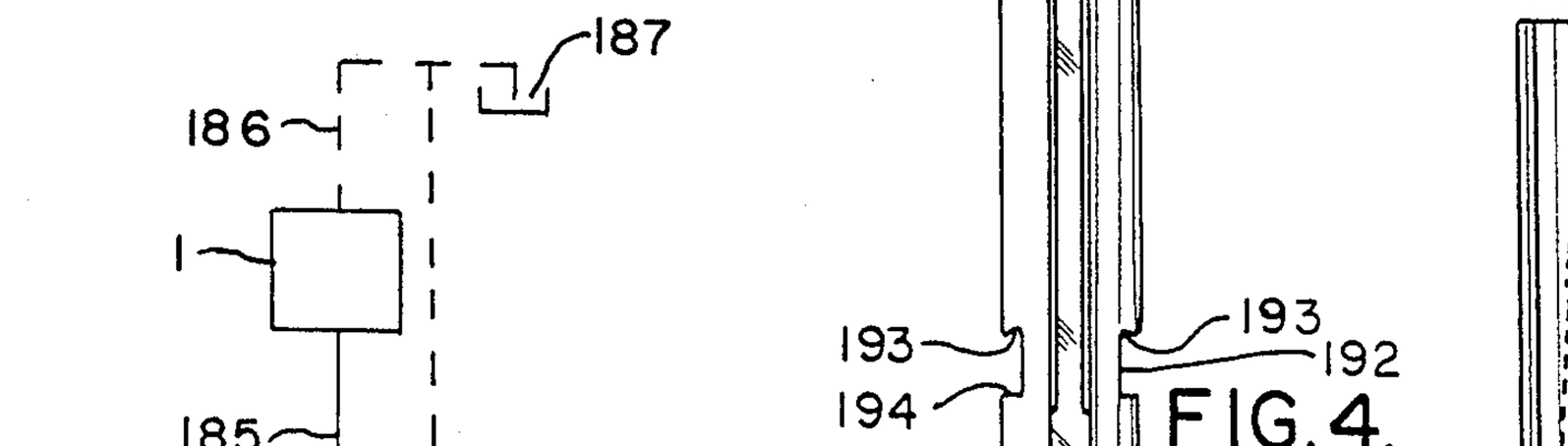

FIG.8.

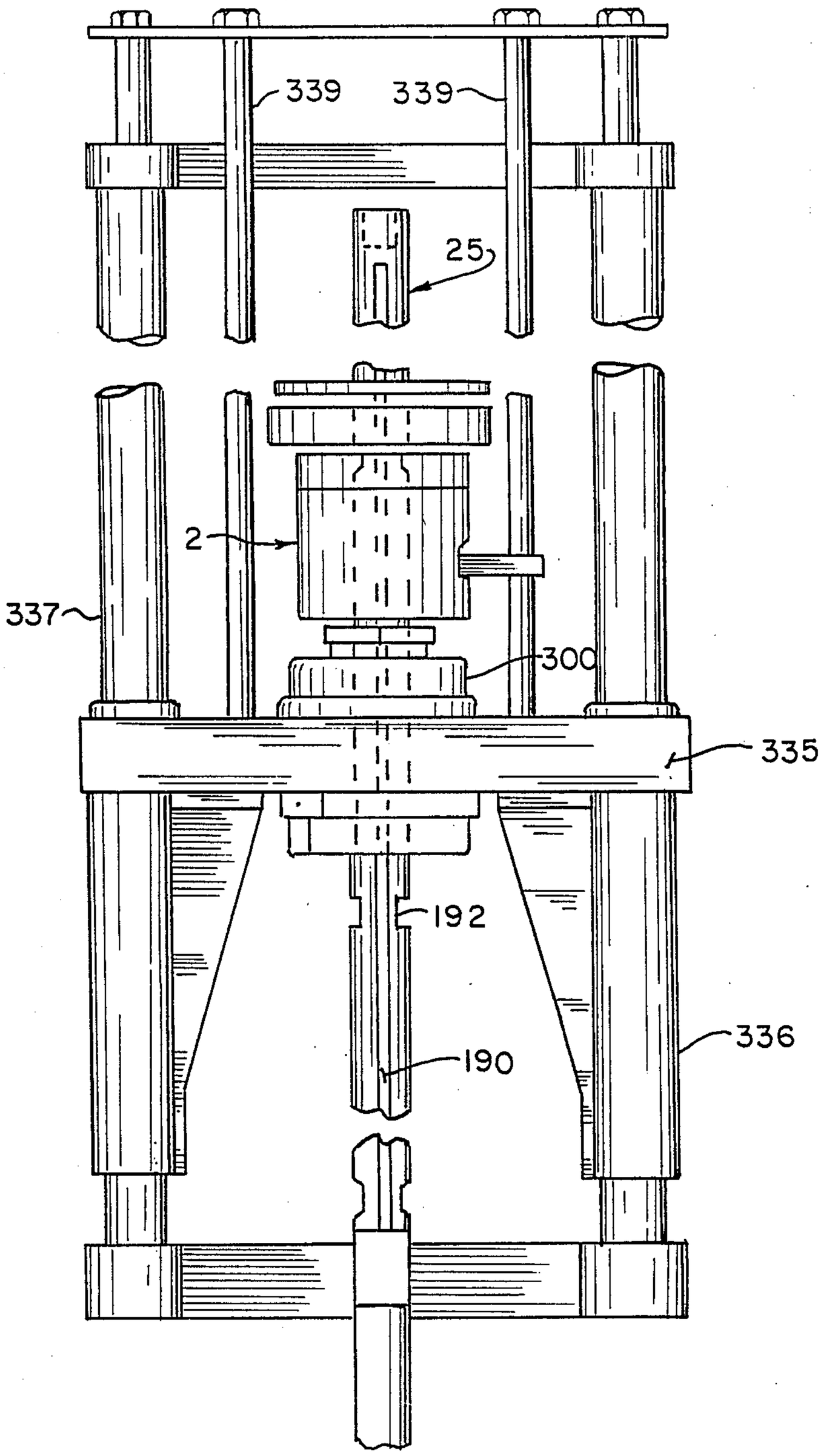

FIG. 10.

HYDRAULIC KELLY BAR CHUCK

BACKGROUND OF THE INVENTION

The hydraulic chuck of this invention is an improvement upon the device shown and described in U.S. Pat. No. 4,393,945. In the device of that patent, a housing is mounted on a spindle rotated by a rotary table, the housing being held against rotation with the spindle, but being free to move axially with the table. A hollow chuck body is fixedly mounted on the spindle, for rotation therewith. A tube mounted on the chuck body has fingers extending axially to cam plungers out of engagement with a kelly bar extending through the spindle. The device has worked well, but it requires a substantial number of parts, the use of O-rings, and sealed bearings that can not easily be relubricated.

One of the objects of the invention is to provide a hydraulic kelly bar chuck that requires fewer parts than the device of U.S. Pat. No. 4,393,945, but operates as effectively.

Another object is to provide such a chuck in which bearings are cooled and lubricated by hydraulic fluid used to operate the chuck plungers.

Yet another object is to provide such a chuck in which a visual indication is given of the withdrawal of the plungers from engagement with the kelly bar.

Still another object is to provide a construction of plungers that minimizes wear and tends to insure engagement with the kelly bar in the course of forcing the kelly bar downward.

Other objects of this invention will be apparent to those skilled in the art in light of the following description and accompanying drawings.

SUMMARY OF THE INVENTION

In accordance with this invention, generally stated, in a rotary drilling apparatus wherein a rotary table is adapted to be moved axially while rotating, the rotary table including a spindle having an axially directed passage through its center of rotation, a kelly bar extending through the passage, the kelly bar having channel-defining shoulder surfaces. A chuck body is mounted on the spindle for rotation with the spindle. Elongated plungers mounted in the chuck body are movable radially with respect to the spindle passage for selectively engaging and disengaging the kelly bar shoulder surfaces. A housing is provided, surrounding a part of the chuck body. The housing is restrained against rotation with the spindle and chuck body. The plungers are mounted in cylinders in the chuck body, and are each provided with a nose that engages shoulders in the kelly bar, an intermediate cylindrical portion and an enlarged annular piston part radially outward of the intermediate portion. The cylinder in the spindle in which each plunger reciprocates has a configuration complementary to the plunger intermediate portion and piston part to receive them closely but slidably. The housing has a fluid passage through it communicating with an annular manifold channel in the chuck body, and the chuck body has fluid passages associated with each cylinder, communicating at one end with the manifold channel and at another end with the cylinder radially inboard of the piston part. The nose of the plunger has upper and lower chordal flats parallel with one another at their leading edges, which are parallel with the kelly bar shoulders. The lower chordal flat is inclined downwardly in a direction toward the shoulders

to define a depending lip that engages the lower shoulder. Means are provided for preventing rotation of the plungers, so as to maintain the nose flats in the proper orientation. Bearings, extending circumferentially around the chuck body, between the chuck body and the housing, are spaced axially above and below the annular manifold channel. Annular seals above and below the manifold channel between the manifold channel and the bearings are designed to leak sufficient of the hydraulic fluid under pressure to lubricate, flush and cool both the bearings and the seals themselves. Drain passages in the housing permit the hydraulic fluid to flow through the bearings and back to a reservoir. Preferably, the flow of fluid through the seals and bearings is on the order of one half gallon per minute at 300 pounds pressure. Preferably the plungers are biased into engagement with the kelly bar shoulders by helical compression springs, and preferably those springs bottom on their radially inward ends on a disc to which a stem is connected that extends radially outwardly through a hole in a cap covering a radially outer, open, end of the cylinder in which the plunger slides. In this way, when the plunger is retracted, the stem protrudes from the housing and can readily be seen. Preferably, also, the lower kelly bar shoulder at each level is sloped downwardly radially inwardly, complementarily to the slope of the lower flat on the plunger nose, so as to tend to cam the plunger inwardly when downward pressure is put on the chuck, hence the kelly bar. Even if this is not done, the slope of the plunger flat serves to lengthen the effective life of the plunger nose. If the nose is straight, wear on the nose tends to produce a chamfer or radius on both the nose and the kelly bar shoulder on which it bears downwardly, which tends to cam the plunger outwardly rather than inwardly.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, FIG. **1** is a top plan view, partly broken away and partly in section, of one illustrative embodiment of hydraulic kelly bar chuck of this invention;

FIG. **2** is a diametric sectional view;

FIG. **3** is a view in side elevation of the chuck;

FIG. **4** is a view in side elevation of a fluted kelly bar, inverted with respect to the chuck shown in FIG. **3**;

FIG. **5** is a fragmentary view in side elevation of a lower end of the kelly bar;

FIG. **6** is a sectional view taken along the line **6—6** of FIG. **4**;

FIG. **7** is a fragmentary view of the upper end of the kelly bar;

FIG. **8** is a schematic view of a hydraulic fluid supply system;

FIG. **9** is an elevational view in a radially outward direction of a plunger part of the chuck shown in FIGS. **1–3**; and

FIG. **10** is a view in front elevation, partly interrupted, of a kelly bar mounting and drive apparatus incorporating the hydraulic chuck of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing and particularly to FIGS. **1** through **3** and **10** for one illustrative embodiment of hydraulic kelly bar chuck of this invention, reference numeral **1** indicates the assembled chuck. The chuck **1** is mounted on a spindle of a rotary table **300**,

supported by a yoke **335** mounted on a pair of slide tubes **336**, slidably mounted on a pair of hydraulic cylinders **337** for vertical motion thereon, as illustrated and described in U.S. Pat. Nos. 3,561,545 and, more particularly, 4,393,945. As in the latter, a pair of support rods or stanchions **339** secured to the yoke transmit the motion of pistons to the yoke. The spindle, as in the device described in U.S. Pat. No. 4,393,945, projects vertically upwardly from the table and has an externally threaded upper section onto which a tubular chuck body **2** is threaded. The chuck body **2** has an axial, cylindrical bore **104**, an internally threaded section **102** of which terminates in a shoulder **103**.

At its upper end, the chuck body **2** has an axially and radially thick head section **105**. The head section **105** is bored and counterbored diametrically to provide, in this embodiment, two plunger receiving cylinders **110**. Each of the cylinders has a uniformly cylindrical inner section **111** extending from the bore **104**, an enlargedly offset piston receiving section **112**, with a shoulder **113** between them, and an open mouth, the edge of which is defined by a chordal flat machined in the outer surface of the head **105** to accept a rectangular cap **20**, which is bolted to the head to serve as a closure for the outer end of the cylinder. The cap **20** has a piston skirt-receiving annular channel **121** in it, a stem port **120** concentric with the channel, and a pair of fingers **125** projecting inwardly radially with respect to the bore !04. Wiper **115** and seals **116** and **117** are mounted in annular grooves in the wall of the cylinder defining the inner and piston sections.

At its upper end, the head section **105** is recessed to accept and mount a wear ring **8**. Below the head section **105**, the outer surface of the body **2** has a circumferential bearing shoulder **135**, seal grooves **136** and **137**, and, intermediate the seal grooves, an annular manifold channel **140**. Below the seal groove **137** the body has a circumferential bearing shoulder **142**. The lower end of the outer wall surface of the body **2** is externally threaded to receive an internally threaded bottom closure ring **10**.

On diametrically opposite sides, hydraulic fluid passages **145** in the side wall of the chuck body, communicate at one end with the manifold channel !40 and, through an opening in the shoulder **113**, with the piston section **112** of the cylinder **110**.

The housing **5** has a cylindrical outer surface, and an axially intermediate, radially inwardly extending boss section **160**, formed with annular upper and lower bearing shoulders **161** and **162**, and a smooth cylindrical inner face **163**. The annular boss section **160** defines, with a radial surface and a circumferential surface of the body, upper bearing cavity **170** and, with a radial bearing shoulder and circumferential surface of the body, and radial surfaces of the closure ring **10**, a lower bearing cavity **171**. An axially extending passage **175** connects the upper part of the cavity **170** and the lower part of the cavity **171**, and communicates at its upper end with an internally threaded passage adapted to be connected to a drain conduit **186**, also shown schematically in FIG. **8**. The lower passages are tapped and plugged. By communicating with the upper end of the passage **175**, the drain system ensures that the cavities are filled with oil, even when the rig is not in operation, and because the chuck is fixed against rotation, the drain passage remains uppermost when the feed mechanism is moved to a horizontal transportation position. A radial passage **180** through the housing wall communicates directly with the manifold channel **140** in the housing **5**. The radially outer open end of the passage **180** is internally threaded to take a fitting on a pressure line **185**, indicated diagrammatically in FIG. **8**, from a pressure source **200**.

The housing **5** is held against rotation by a retainer **29**, bolted securely to the housing, in the same way in which the retainer **29** of the device shown in U.S. Pat. No. 4,393,954 operates.

Ball bearings **12** and **13** are mounted in the cavities **170** and **171** respectively to facilitate the rotation of the chuck body **2** with respect to the housing **5**. Low pressure seals **183** and **184** are mounted between the inner wall of the housing, and the outer wall of the chuck body and an outer axially extending wall of the closure ring **10**, respectively, to seal the chambers **170** and **171**, respectively.

Seals **36** and **37** are seated in the seal grooves **136** and **137** respectively. The seals **36** and **37** are, in this embodiment, Teflon impregnated bronze seals, which ordinarily would not be suitable for high pressure seals under the conditions of rapid rotation to which seals in a chuck of this sort are subjected. However, they are adapted to and intended to leak under pressure, so as to permit a substantial flow of oil through them and into the bearings **12** and **13**, thence through the drain line **175** and drain conduit **186**, to a reservoir **187**. This not only lubricates and flushes the seals and bearings, but cools them as well. The flow can be on the order of a half gallon per minute.

It is not desirable in the present application of the deliberate leakage of oil past the seals to have oil under high pressure in the bearing and outer seal cavities. For example, if oil at about 300 psig is supplied to operate the plungers, the pressure drop across the seals **36** and **37** can be about 295 psig, supplying oil to the bearings and outer seals **183** and **184** at about 5 psig. Such an arrangement can be used in other applications as well, although this particular application has unique advantages because of the conditions under which drilling rigs of this type operate and the speed of rotation (e.g. 600 RPM) and large size of the seals (e.g. on the order of at least six inches, o.d.).

Plungers **3** are slidably mounted in the cylinders **110**. The plungers **3** are identical. Each plunger has a nose **148**, a cylindrical intermediate portion **149**, and an enlarged annular piston part **150**. The piston part has a skirt **151** that slides into and out of the channel **121** in the cap **20**. Between the cylindrical portion **149** and the piston part **150** is a stepped shoulder with a spacer ledge **155**, and a recessed piston head surface **152**. The plunger has a central well **153** opening through the end of the plunger opposite the nose **148**, and two blind holes **154**, diametrically opposite one another outboard of the well **153**, into which the fingers **25** of the cap **20** extend.

The nose **148** has an upper chordal flat **156** and a lower chordal flat **157**. The radially inward leading edges of the flats **156** and **157** are parallel. However, the flat **157** slopes upwardly in a radially outward direction with respect to the bore **104**, to form a depending lip **158**. The flats **156** and **157** are maintained in the proper orientation by the fingers **125** of the cap **20** extending into the holes **154**.

In this embodiment, an indicating device **15** consists of a disc **130**, a radially inner flat surface of which bears against a bottom wall of the well **153**, and a stem **131**, secured to the opposite face of the disc, projecting radi-

ally into the port **120** in the cap **20**, in which it is slidably journaled. A helical compression spring **17** bears at one end on the radially outer face of the disc **130**, and at its other, on a surface of the cap **20**. The spring **17** biases the plunger inwardly. When the plunger is moved radially outwardly, the stem **131** projects from the cap **20**, giving visual evidence that the plunger has moved outwardly.

Referring now to FIGS. **4** through **7** for one embodiment of fluted kelly bar for use with this invention, the kelly bar **25** is shown in FIGS. **4, 5** and **7** as upside down with respect to the chuck **1** in FIG. **3**, but the construction of the kelly bar will be apparent from the drawing. The kelly bar **25** has keyways **190** extending axially of the kelly bar and diametrically opposite one another, as shown in FIGS. **4** and **6**, and extending slightly beyond upper and lower channels **192** each defined by a lower shoulder **193** and an upper shoulder **194**. There are intermediate channels, not here shown, as described in U.S. Pat. No. 3,561,545. The channels extend chordally of the kelly bar, on diametrically opposite sides, as shown in FIGS. **4** and **6**. In the embodiment shown in FIGS. **4–7**, the lower shoulder **193** is sloped complementarily to the slope of the lower flat **157**. As has been explained above, this construction tends to cam the nose of the plunger radially inwardly, and to avoid the problem of chamfering or rounding of the surface of the plunger engaging the shoulder. However, as has also been explained, the shoulder **193** can be made planar perpendicularly to the axis of the kelly bar, like the shoulder **194**, as is conventionally done and as is shown in shadow in FIG. **2**, because the lip **158** of the nose of the plunger of this, preferred embodiment of chuck, will still serve a useful function, prolonging the life of the plunger, and inhibiting the formation of chamfers or radii. The kelly bar is prevented from rotation in the chuck by keys **107** held in place in much the same way as the key **30** of the device shown in U.S. Pat. No. 4,393,945. The kelly bar is thus rotated by the chuck body **2** which is rotatably driven by the spindle. This is conventional.

Referring to FIG. **8**, a valving system is shown that is used on the commercial drilling rig, but only that part of it which has to do with the operation of the chuck will be described. These include a source **200** of oil under pressure, a supply line **201** from the source **200** to a control valve **202** with a lever **203** by which the supply line **201** is connected to and disconnected from a port **204** connected by a line **205** to a pressure reducing valve **206**, which is connected to the pressure line **185** connected to the passage **180** of the chuck. When the lever **203** is thrown to the position at which the fluid from the source **200** reaches the passage **180**, the fluid, acting on the piston head wall **152** and then also the face of the spacer ledge **155**, moves the plunger, against the bias of the spring **17**, to a position clear of the shoulders **194** and **193** of the kelly bar. It will be seen that in the embodiment of kelly bar shown in FIG. **4**, in which there is an undercut bottom lip, the plunger will retract with difficulty, if at all, when there is pressure being applied through the chuck to the kelly bar. However, that is not a practical problem, because the plungers are not retracted under those conditions. When the pressure is applied to the pistons, as has been indicated, the controlled leakage of the oil through the seals **36** and **37** lubricates, flushes and cools both the seals and the bearings **12** and **13**. This occurs frequently, because the chuck is raised to the next kelly bar channel in the course of drilling, as the drill string is driven into the earth. In each case, the valve lever **203** is thrown into a position in which the oil in the lines **185** and **205** drain, in response to the bias of the spring **17**, into a sump or reservoir, permitting the spring to drive the nose **148** into the next channel **192** of the kelly bar as the table is raised or lowered, depending upon whether the drill string is being lowered or raised.

Numerous variations in the construction of the device of this invention within the scope of the appended claims will occur to those skilled in the art in light of the foregoing disclosure. Merely by way of illustration, seals different from the Teflon-impregnated bronze seals **36** and **37** can be used, as long as they are capable of permitting flow through them, and different flow rates can be accomplished, as has been indicated above. The seals should be such as to permit flow at greater pressures, to minimize scoring of the revolving surface, in contradistinction to O-rings and lip seals, which tend to be forced more tightly into engagement with the rotating surfaces as the pressure is increased, which increases wear, and tends to promote the formation of grooves. In certain applications where a large flow is thought to be necessary or desirable, or can be tolerated, the sealing means may be provided simply by the restriction produced by close tolerances between facing surfaces of the body and housing or their equivalents, without separate seals. Different biasing means can be employed for the plungers, including double acting hydraulic connections, although the illustrative embodiment has advantages of simplicity and certainty in its operation. Different guide-orienting means can be used for the plungers, as, for example, fingers on the skirt projecting through holes in the cap, or flats on the skirt area and cylinder. The manifold channel can be provided in the inner wall of the boss **160** or the seal grooves **136** and **137** can be provided in the inner wall of the boss **160**, or both. These are merely illustrative.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a rotary drilling apparatus wherein a rotary table is adapted to be moved axially while rotating, said rotary table including a spindle having an axially directed passage through its center of rotation, a kelly bar extending through said passage, means carried by the rotary table for transmitting positive rotational force from the rotary table to the kelly bar, said kelly bar having axially spaced upper and lower shoulder surfaces defining a plurality of axially spaced channels, elongated plunger means moveable radially with respect to said spindle passage carried by said rotary table, for selectively engaging and disengaging said kelly bar shoulder surfaces, actuating means for causing said plunger means to engage with and disengage from said shoulder surfaces, a tubular housing held against rotation but to permit axial movement of said housing with said table, the improvement comprising a chuck body connected to said spindle, said chuck body having an axial bore to receive said kelly bar and a radially extending cylinder cavity, in which said plunger means are mounted, said plunger means having a nose on a radially inner end, said nose selectively extending within said kelly bar channels for engaging said kelly bar shoulder surfaces, a cylindrically intermediate portion and an enlarged annular piston part radially outward of said intermediate portion, said cylinders in said body in which said plungers reciprocate having a configuration complementary to said plunger intermediate portion

and said piston part to receive them closely but slidably, said housing having a fluid passage through it communicating with an annular manifold channel, and said body having fluid passages associated with each cylinder communicating at one end with said manifold channel and at another end with said cylinder radially inboard of said piston part.

2. The improvement of claim **1** including means for preventing rotation of said plungers.

3. The improvement of claim **2** wherein the said means for preventing rotation of said plunger comprise a cap, fixed on a radially outer end of said cylinder, and fingers, said fingers extending into blind passages in one of said plunger and cap.

4. The improvement of claim **3** wherein the passages are in said plunger and said fingers are integral with said cap.

5. The improvement of claim **1** wherein said nose has upper and lower chordal flats with leading edges parallel with one another and parallel with said kelly bar shoulders.

6. The improvement of claim **3** wherein said lower chordal flat is inclined downwardly in a direction toward said lower shoulder surface.

7. The improvement of claim **6** wherein the lower of each said kelly bar shoulders is sloped downwardly radially inwardly complementarily to said lower nose flat.

8. The improvement of claim **1** including means for continuously biasing said plungers radially inwardly.

9. The improvement of claim **8** wherein said biasing means comprise a helical compression spring.

10. The improvement of claim **9** including a disc with two radial faces one of the faces of which is seating against a bottom surface of a well in said plunger and the other face bears against an end of said spring, and a stem connected to said disc, said stem being journaled in a passage in a cap closing said cylinder whereby, when said plunger moves outwardly against the bias of the spring, the stem will protrude from said cap to provide a visual indication that the plunger has moved free of the kelly bar shoulders.

11. The improvement of claim **1** wherein oil under pressure is supplied to said fluid passages, hence to said manifold, said improvement including bearings extending circumferentially around said body, located between said body and said housing and spaced axially above and below said annular manifold channel, and annular seals above and below said manifold channel between said manifold channel and said bearings, said seals leaking sufficient of said oil under pressure to lubricate and cool said bearings.

12. The improvement of claim **11** including an axial passage in said housing communicating at its upper end with an upper area of said upper bearing and communicating at its lower end with a lower area of said lower bearing, and communicating with a drain line, whereby said oil leaking through said bearings is returned to a reservoir.

13. The improvement of claim **11** wherein the leakage is on the order of one-half gallon per minute.

14. In a rotary drilling apparatus wherein a rotary table is adapted to be moved axially while rotating, said rotary table including a spindle having an axially directed passage through its center of rotation, a kelly bar extending through said passage, means carried by the rotary table for transmitting positive rotational force from the rotary table to the kelly bar, said kelly bar having axially spaced upper and lower shoulder surfaces defining a plurality of axially spaced channels, a plurality of elongated plunger means moveable radially with respect to said spindle passage carried by said rotary table, for selectively engaging and disengaging said kelly bar shoulder surfaces, means for causing said plunger means to engage with and disengage from said shoulder surfaces, a tubular housing held against rotation but to permit axial movement of said housing with said table, the improvement comprising a chuck body connected to said spindle, said chuck body having an axial bore to receive said kelly bar and a plurality of radially extending cylinder cavities, in which said plunger means are mounted; each of said plunger means having a nose on a radially inner end, said nose having chordal flats, leading edges of which are parallel with shoulders defining channels in said kelly bar, and the lower of which nose flats is sloped downwardly toward a lower kelly bar shoulder to define a nose engaging said lower shoulder when said plunger is moved radially inwardly and the chuck is moved downwardly, said plunger having a cylindrically intermediate portion and an enlarged annular piston part radially outward of said intermediate portion, said cylinders in said body in which said plungers reciprocate having a configuration complementary to said plunger intermediate portion and said piston part to receive them closely but slidably; means for preventing rotation of said plunger means in said cylinders comprising a cap, fixed on a radially outer end of said cylinder, and fingers, said fingers extending into blind passages in one of said plunger and cap; plunger biasing means in the form of a helical spring mounted between said cap and said plunger; said housing having a fluid passage through it communicating with an annular manifold channel, and said body having fluid passages associated with each cylinder communicating at one end with said manifold channel and at another end with said cylinder radially inboard of said piston part; means for supplying oil under pressure to said fluid passages, hence to said manifold; bearings extending circumferentially around said body, located between said body and said housing and spaced axially above and below said annular manifold channel, and annular seals above and below said manifold channel between said manifold channel and said bearings, said seals leaking sufficient of said oil under pressure to lubricate and cool said seals and bearings; and indicating means, including a disc with two radial faces, one of the faces of which is seating against a bottom surface of a well in said plunger and the other face bears against an end of said helical spring, and a stem connected to said disc, said stem being journaled in a passage in said cap closing said cylinder whereby, when said plunger moves outwardly against the bias of the spring, the stem will protrude from said cap to provide a visual indication that the plunger has moved free of the kelly bar shoulders.

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